Locking Screw Fixation for Total Hip Prosthesis

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INTRODUCTION: While the general consensus may be that hip replacement surgery is very successful, the Swedish National Hip Register[1], which has been tracking all hip replacement surgery performed in Sweden since 1979, presents a different picture. The Register shows that the revision rate for non-cemented stems over all age groups is approximately 17.5% at 10 years. Furthermore, when looking at only the age group of patients less than 50 years of age, the revision rate at 10 years increases to almost 25%. From their data it is estimated that there is a worldwide revision burden of between 20 to 25%.

It is well established that a key to long term success of total joint replacement implants is early stabilization. Some stem designs utilize screws to provide additional stabilization of the stem to the bone. These screws are similar to those used with interlocked nails. However, these constructs are prone to deformation under load, fretting, and mechanical failure.

Locking screw fixation of trauma plates, called internal fixators, introduced in the late 80's brought many advantages to orthopaedics. Iatrogenic bone damage was reduced, resistance to infection was increased, fretting corrosion was practically eliminated, and the plate/screw constructs remained stable and intact. Application of the locking screw principles to intramedullary anchorage of joint replacement components was a logical extension from internal fixation.

Locking screw fixation of total hip replacement stems has been successfully demonstrated in over 15 years of clinical experience in over 7500 dogs.

METHODS: A short curved stem was chosen for the design to reduce loss of proximal femur cancellous bone, to allow one stem shape to fit both left and right sides, and to facilitate the surgical approach. The medial endosteal contour of the proximal femur was determined by averaging contours from 75 A-P x-rays corrected for ante version of the neck. The length and final shape were arrived at through iterative FE design, handling studies in cadavers, and trialing during clinical procedures.

Stresses in the stem, screws and the bone were calculated using FE analysis with the applied load

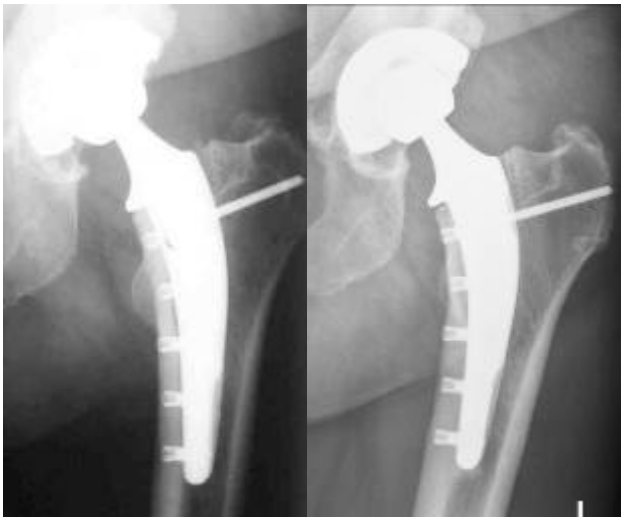

Fig. 1: AP x-rays of 53 year old female shown with a locking screw fixation stem l)immediate post op r) 14 months post op.

defined according to ISO 7206-4, -8. Fine tuning of the stem shape was achieved through iterative FE analysis. A collar, lateral recesses, extension of the proximal screw and neck transition sections were added/modified in order to reduce critical stresses in either the implant or the bone.

Fatigue testing of the stems according to ISO 7206-4, -8 was performed (Fraunhofer Institute, Freiburg, Germany) using both the old fixation level (more demanding) and the new level. Testing was also performed with the screw holes left empty to assess the risk of stem failure due to surgical error. A final series of tests were performed using mechanically equivalent femurs constructed from glass/epoxy (Sawbones).

RESULTS: The stem successfully passed all series of fatigue testing, even with the screw holes left empty.

DISCUSSION & CONCLUSIONS: Clinical follow-up data from use of a similar design in dogs has shown only 0.65% aseptic loosening of the stem in 460 consecutive cases[2]. As anticipated by the results in dogs, initial clinical results in human show bone apposition toward the medial surface of the implant and no remodeling of the lateral cortex.

REFERENCES: [1] *Swedish National Hip Register*. [2] A.Vezzoni, BVOS, Birmingham,UK,Apr. 2008.